BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

SUBJECT: Apollo 9 Support Systems Observations - Case 900

DATE: March 28, 1969

FROM: L. A. Ferrara, Jr.
J. T. Raleigh

ABSTRACT

[redacted]

During Apollo 9, communications using GOSS CONFERENCE, Net 2, and PAO release line were monitored at the Mission Status Room of FOB 6. The operational support systems successfully supported the mission although several problems were observed which appear to merit further investigations. The technical areas which appeared to cause operational problems included the down-link voice processing, the Apollo Range Instrumentation Aircraft and the Data Storage Equipment voice quality.

The prime spacecraft-ground channel (GOSS CONF) gives some feel for the support to the conduct of the mission, but at least Net 2 is needed to make more meaningful technical observations about the use and adequacy of the operational support.

Several specific topics are discussed and a summary of observations is attached.

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MEMORANDUM FOR FILE

I. Introduction

Members of MOS (Bellcomm) monitored Apollo 9 communications using GOSS CONF (Net 1), Net 2 and the PAO loop at the Mission Status Room of FOB 6 during the Apollo 9 mission whenever the astronaut crew was awake. In addition, communications were also monitored at KSC on the launch day. The purpose was to observe first hand the character of the operational support and problems during the mission in order to identify those which may require further review.

This memorandum contains a discussion of the method of monitoring and major problems noted. The utility of the available monitoring facilities is also discussed. The appendixes contain a summary of the observation times and a chronology of the observations.

The operational systems successfully supported the mission although several problems did occur which appear to merit further investigation. It became very obvious that at least the Net 2 channel was needed in addition to the prime spacecraft-ground communication channel, GOSS CONF or Net 1, to provide reasonably complete observations.

II. Brief Description of Monitoring Facilities

The primary monitoring location was the Mission Status Room (MSR) of FOB 6 and the use of GOSS CONFERENCE or Net 1. This room also had available PAO Technical Commentary which often directly relayed Net 1. In addition, it carried PAO commentary, delayed or summarized Net 1 conversations, and the press conferences. Of more significance to mission support was the Net 2, (MCC-MSFN) station conference loop. The quality of this channel to the MSR was poor, but the nature of the conversations were very significant to the understanding of mission support. Commercial television and special circuits were also available for launch and recovery.

When the MSR facilities were available to the Bellcomm observers so that they could select and adjust monitor volumes as desired, it was possible to follow the mission operation quite well. For the launch and recovery phases the lack of

positive monitoring control and the numerous people present in the MSR made the monitoring relatively ineffective.

At KSC, Net 1 in CD & SC, Net 1 and Flight Director (FD) Channels in the Mission Director's Office, and (when Net 1 on the OIS-RF channel 125 was unsatisfactory) an unoccupied position in Firing Room 1 which had Net 1, 2, FD, nd PAO release line were used. The observations from these positions would, therefore, be different than those in the MSR. The FD loop gives a greater insight to the nature of the Net 1 uplink discussions with some inputs from the network operation.

Transcripts of Net 1 from MSC and portions of PAO release have also been used and are a valuable supplement to the real time monitoring of several channels. The transcripts obviously do not contain Net 2 or FD discussions nor do they report the quality of the communications.

III. Major Observations

(a) Launch Phase Voice Communications

The procedure for the early phase of this launch was different than previous launches in that the ALDS A/G 1 circuit was used prior to the Net 1. It appears that all the necessary conversations were relayed, but it is not clear that the redundancy was fully available in the time frame when the Mode 1B callouts were made. In addition, the spacecraft originated messages toward the end of the second stage burn seemed to have been interrupted.

It should be remembered that the duplex VHF voice configuration of Apollo 9 was previously used on Apollo 7. A significant improvement in performance was noted probably as the result of changes in procedures. Because of these changes, a detailed review of the performance and backup capability may be desirable.

(b) Orbit Insertion Determination

There was a significant delay in determination of the orbit at MCC following insertion. Because of a number of problems, the CYI tracking site provided the first usable orbital data. A significant item was the modification of the ALDS and RSDP software to process the LVDC data which was required (according to a KSC report) because of an incorrect format in the LVDC data. This modification was done and some of the data was recovered. The second burn SIVB data was usable in real time. With the previous system testing, it is not clear why this problem occurred. (Subsequent investigation indicates one of two possible failures in the IU as the probably cause.)

(c) Voice Relay Through Tananarive

The voice relay at TAN ranged from totally unusable to very loud and clear with the former case predominating. It is recognized that the HF radio propagation is a significant limitation in this station's usefulness, but it was disturbing to note the number of times during which the Comm Techs at Houston and TAN could very effectively communicate and yet voice relay with the spacecraft was not possible.

(d) Apparent Ground Communication Patching Errors

There were several instances where messages to the spacecraft were delayed apparently due to ground station patching errors. These include the backup S-Band communication checks at CRO on the first revolution and the subsequent checks at CRO and HSK on the second day.

(e) DSE Voice Quality

The quality of the Data Storage Equipment (DSE) voice and LM PCM data was apparently quite variable based on comments made to the crew. Some of the variation may have been due to ground station equipment capabilities and processing.

(f) Apollo Range Instrumentation Aircraft

The performance of the ARIA was extremely variable. The first two attempts were poor and the crew requested MCC not to try on the third attempt because of the noise that it caused in their ears. Later in the mission and on recovery day, several very good two-way voice relays were accomplished although it was difficult to follow when USB and when VHF radio was being used.

On the day of the CSM-LM rendezvous, ARIA-5, was positioned near Africa. ARIA-5 reported on Net 2 that it was in contact with the spacecraft, that it was uplinking and hearing the spacecraft responses, but the voice relay to MCC was never accomplished. There appears to have been a technical problem or procedural difficulty on Net 1 that merits investigation.

(g) Tracking SIVB Stage During Its Third Burn

Data in Houston and subsequent announcements on the PAO line indicated that there had been a loss of trajectory and tracking data during the final burn of the SIVB over Guam. Net 2 discussions raised a question about the tracking sources that were available and used at Guam.

(h) Lack of Voice During First TV Pass

The quality of the television picture from the LM was very good on the first pass on March 5. Unfortunately, it was possible to see the crew talking but with the exception of a few comments, it was not possible to hear the crew. It was some five hours later when the spacecraft configuration was discussed and reconfirmed with the crew on Net 1.

On the subsequent day, the MILA and GDS stations were instructed to remove their VOGAA's (Voice Operated Gain Adjusting Amplifiers) which are used for receiver squelch circuitry in the USB downlink. The spacecraft voices were heard clearly on the second television pass which was relayed through the GDS and MILA stations.

The VOGAA's were also discussed on the fourth mission day with ACN and HAW. The intent of ISI #161 which was previously issued to the MSFN stations was reviewed.

Earlier on the fourth day, there appeared to be a problem at Madrid because MCC could not hear the spacecraft. The station recordings did not contain spacecraft voice signals even though it was reported that the USB operator at Madrid had heard the crew. The missing voice can be explained if the VOGAA is located ahead of the recorders and Comm Tech console in the station voice communications system configuration.

Although it could be said that these problems might be solved by VOGAA adjustment, the impact of extensive use of VOGAA's throughout the MSFN on voice communication reliability should be reviewed.

(i) No Up Voice During EVA

During the EVA activities over the United States mainland, MCC was not heard by the spacecraft crew which was later noted during the worldwide TV broadcast from the LM. This problem occurred over several stations and unfortunately discussions on Net 2 did not define the nature of the difficulty. This problem merits further investigation.

(j) Command System Anomalies

There appeared to be two different types of command anomalies. On the sixth day, for about two hours, MCC was unable to command the CSM. The second type of command problem usually occurred at low elevation angles and/or at the end of station passes.

The CSM problem was apparently cleared as a result of a change in the spacecraft configuration. Based on the information on the circuits available in the MSR, it is not possible to explain this problem although it was reported cleared.

The second problem arose from the use of ground commands to change the CSM antenna and communication system configuration following an announced loss of downlink signal lock by an MSFN station. This made it appear, in some cases, that the command system was not working.

(k) Ranging on LM

During the LM APS burn to depletion, TEX reported problems with ranging on the LM. It is not known if this was an LM or TEX problem.

(l) Private Communications

Several private discussions with the crew were held by MCC. During one, the MSR Net 1 feed was removed just after the discussion started; in the other cases, the entire communication was private (not heard) as monitored at MSR.

With Net 1 and the PAO release circuit it was also possible to note the degree of monitoring that was provided in the information to the public. PAO releases were quite useful because of questions that were raised as a result of TV and Radio commentary.

IV. Summary and Conclusions

The Apollo 9 mission was complex as it involved two manned spacecraft for the first time and there were some new support problems. In addition, some problems were experienced which, although they did not seriously impact the Apollo 9 mission, may be significant to the overall mission support for future missions. The problems do merit resolution.

Monitoring of Net 1 alone does not provide sufficient information about the network support. Real-time monitoring of at least Net 1 and Net 2 are needed to obtain an assessment of the nature of the support problems. The addition of the PAO loop provides a meaningful summary of the visible problem areas although the information content is not always complete.

In our opinion, monitoring of these loops can identify most of the mission support problem areas that merit additional investigation. These observations will permit Mission Operations to insure that satisfactory resolution of the problem areas is obtained.

L. A. Ferrara, Jr.

J. T. Raleigh

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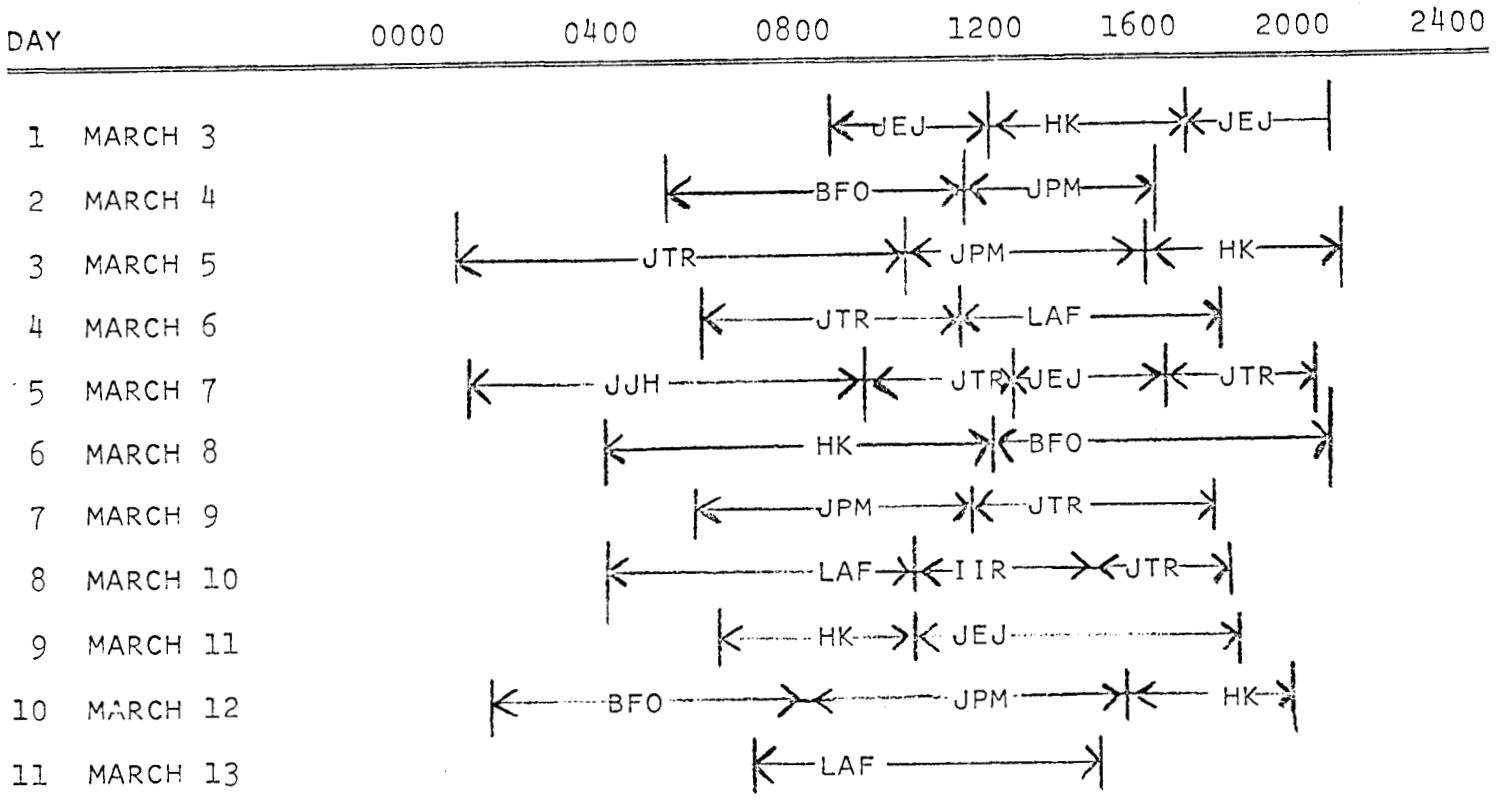
Attachments



OBSERVERS LEGEND:

LAF - L. A. FERRARA, JR.
JJH - J. J. HIBBERT
JEJ - J. E. JOHNSON
HK - H. KRAUS
JPM - J. P. MALOY
BFO - B. F. O'BRIEN
JTR - J. T. RALEIGH
IIR - I. I. ROSENBLUM

DIGEST OF OBSERVATIONS OF VOICE COMMUNICATION DURING APOLLO 9

The voice communications were monitored during periods when the spacecraft crew was awake.

TIME (GET-HOURS AND MINUTES)	COMMENTS
00:04	CDR reported Helium pressure for SPS went to zero at lift-off.
00:08	Spacecraft reported "comm is beautiful. We had no trouble with comm on launch at all."
00:08	Spacecraft (CDR) started to say something about vibration, "about 8 " (never finished). Suspect that he just stopped talking, but there may have been breakoff in voice communications.
00:11	Tracking data, apparently from VAN, looks very erratic on GSFC-televised γ vs. V/Vr plot. MSC-generated plots during launch, characteristically become noisy when ship data is processed, but this data appears 2-3 times "noisier."
00:38	Voice communications via TAN was poor. Other sites relaying spacecraft voice during launch phase were satisfactory.
01:10	Flight control (HOU) trying to reach spacecraft (S/C) via Huntsville (HTV). S/C response was broken. HOU deferred contact until stateside pass.
01:24	HOU reported S/C loud and clear on voice via Redstone. Net 1 observation in MSR was that the S/C volume was quite low - but clear. (5 x 3)
01:28	HOU says they lost data. S/C said they had switched antennas from Omni-Antenna B to D.

TIME (GET)	COMMENTS
01:40	Unidentified station reported bad biomed from CDR on Net 2.
01:48	HOU to S/C. Apparently S/C replied since HOU continued conversation. Only the HOU side of conversation was observed here.
02:10	HOU to TAN - "verify that CAPCOM is uplinking properly" - TAN "Roger"
02:11	S/C about 4 x 3 via TAN - initial part of message from S/C not heard by HOU (or at Net 1 monitor position).
02:32	Net 2 discussion on S/C rejection of command - could have been either CRO or HSK.
02:34	S/C voice about 3 x 4 via ARIA (ARIA link very noisy - sounds like intermittent squelch operation)
03:21	HOU says S/C volume very low (no S/C audio heard at MSR monitor position)
03:24	S/C complained communications via ARIA was too noisy and requested that the ARIA relay be turned down. HOU complied.
04:24	HOU calling S/C via HAW with no response.
04:25	HOU Comm. Tech test on Net 1
04:26	S/C was 5 x 5 via HAW - HOU says trouble was patching at GSFC
04:46	S-IVB second start - (S/C became very weak and mushy - has trouble reading HOU - improved to 4 x 4 by 04:54)
06:10	GWM lost IU downlink at 40° elevation - (later said that programmed track dropped out.)

TIME (GET)	COMMENTS
06:14	S/C was 5 x 5 via TEX - spacecraft reported they read HOU but apparently HOU had not been reading them - voice circuit good now (cause of problem unknown)
06:30	Problem with CCS telemetry reported (nature of problem unknown.)
06:53	TAN pass was unsatisfactory from voice communications standpoint. Spacecraft voice was about 4 x 1 when contact, after long delay, was established.
07:38	RED pass characterized by 3 distinct periods: (1) No contact established for over 3 min after AOS (2) Voice was weak but very clear (2 x 5) (3) Voice changed to loud and fairly clear (5 x 4)
08:26	TAN surprisingly good this pass.
20:40	In general, communications were good during this period, although there were noticeable differences between stations. The downlink through ANG was very weak, while no downlink at all was heard through VAN. At the beginning of the ANG contact, however, the downlink was judged very good. It was later reported by Apollo Control (PAO) that the trouble was caused by the ground lines to GSFC.
20:50	The downlink was good through MAD.
23:30	The S/C crew commented on the amount of interference resulting from use of the VHF frequency by aircraft controllers.

TIME (GET)	COMMENTS
23:35	The downlink was generally weak through GYM, MIL and CYI and was cutting out occasionally through GYM and MIL.
24:46	Feedback was heard on the circuit (Net 1) through HTV.
25:47	TAN unreadable
26:04	NET 1 - CRO distorted
26:28	NET 1 - HTV comm weak but clear with background static.
26:34	NET 1 - Over HAW - when spacecraft antennas were switched, downlink voice improved from a low level to 5 x 5.
28:47	NET 1 - Apollo 9 - Houston "Oh! Tremendous comm this pass."
28:57	No voice communications via TAN
40:51	Spacecraft commented twice on low level of uplink voice through GUAM during state vector update but apparently had no problem reading message.
43:28	Spacecraft cabin noise was very noticeable during conversation through CYI.
44:16	HSK locked on to sideband of spacecraft signal and could not derive PCM data. Had to break lock and reacquire
44:23	Houston commented to "Spider" through MER that they had a lot of noise and a steady high tone on spacecraft downlink coming up on CRO station.
46:30	No USB voice downlink was observed during TV pass over MILA. When VHF voice was remoted there was a loud squeal on the voice signal from "Spider."
47:28	No biomed data received from spacecraft via HSK because none coming down from LM.

TIME (GET)	COMMENTS
47:34	Spider (LM) can read Gumdrop (CSM) but apparently cannot hear Houston uplinking through HSK.
47:43	Good quality two-way voice communication to LM and CSM observed through the MERCURY station.
47:53	Made contact with RED. Navigation check to S/C - loud and distorted. Spider - MSC "breaking up pretty badly"
48:08	NET 1 - Gumdrop to MSC - loud but with some distortion.
48:20	Blast of noise twice
48:34	Interference - garbled female voice, whistles, fluctuating background noise level on Net 1
48:36	MSC unable to raise GUMDROP and SPIDER through TAN.
48:53	GUMDROP & SPIDER read MSC over TAN but not vice-versa
49:28	SPIDER, GUMDROP - MSC through RED - no response; then GUMDROP asked to pass data to SPIDER from MSC (communications sounds somewhat hollow)
49:38	MSC - SPIDER communications cut off - message repeated.
49:44	Communications from spacecraft were distorted during burn
49:51	S-band from VAN with frying sound
50:13	GUMDROP - MSC through TAN - lot of noise but no communications
50:28	CRO reported on Net 2 that they are in Simplex B Configuration for A/G voice. Receiving VHF B from spacecraft, VHF uplink blocked. Two-way S-Band to CSM. VHF prime remoted to MCC. Will remote S-Band when good lock obtained.

TIME (GET)	COMMENTS
50:36	CRO - S-band back-up voice; communications breaking up.
50:38	SPIDER - MSC loud and clear; 5 x 5 voice check on back up - crew cut out at count of 3 using PTT
50:39	HSK - SPIDER Spacecraft signal was low level but clear
50:43	SPIDER - MSC - did get back up voice
51:19	MSC could not copy spacecraft via Texas. Missed transmission and asked for repeat.
51:50	TAN-VHF antenna red.
52:03	Unintelligible crosstalk on Net 1
52:09	Spacecraft 5 x 5 via CRO - HOU query on VOX sensitivity spacecraft said it was 8.5 to 9. They could read HOU but apparently the ground was not getting them.
52:47	HAW says the command transmission was attempted after HAW had turned their modulation off and so the command was not uplinked.
53:28	During press interview (on PAO release line) Kranz (Flight Director) stated that they had been able to accomplish about every other communication check. Major problem was that MSFN sites reconfiguring the ground network, had not patched up the proper line back to MCC.
54:35	PAO taking the line down for private conversation between crew and MCC at the request of the crew (no further conversation heard on Net 1).
55:34	PLSS communications checks recorded at sites - AOK but had some trouble passing them on to MCC (S/C 5 x 5 via GWM)

TIME (GET)	COMMENTS
56:30	Had good ARIA relay
67:38	MADRID reports they have downlink voice from spacecraft but it apparently is not getting back to Houston. Very bad circuit noise observed on Net 1. During the last pass (67:00 to 67:45) the spacecraft levels were very low while the Houston voice and Quindar tones were of equal level and at a very high volume.
67:45	CYI USB downlink voice level was noticeably lower than VHF downlink voice levels and the down voice levels from other stations.
70:16	Houston voice signal was of considerably higher level (10-15 VU) than Goddard voice during a keying test.
72:03	BDA only had noise on the spacecraft command downlink but voice comm checks with PLSS using VOX sounded very good. Houston echo heard on the downlink because of VHF relay mode.
72:50	PLSS communication was clear, slightly hollow and of lower level through Gumdrop via CRO Station.
73:23	MCC uplink signal observed as loud echo on downlink during EVA relay, but it did not inhibit voice signal--could be read.
73:37	Crewmen could be clearly heard talking among themselves. MCC was unable to raise any of them through the BDA station.*
73:44	MCC could not raise crew through VAN.

*Note: Lack of uplink communication to spacecraft from some stations during last pass was apparently caused by these stations not being in the USB/VHF simo configuration for uplink. The Spacecraft crew had its S-Band volume turned down and could only receive VHF. Several sites were transmitting USB only.

TIME (GET)	COMMENTS
73:45	Crew could be heard clearly on USB on Net 1.
73:50	Spacecraft was heard loud and clear by MCC on Simplex A through CYI. Two way communication reestablished.
74:05	Crew did not respond to MCC call through TAN. Uplink of MCC voice verified by Communication Technician at TAN.
74:39	Spacecraft and stations preparing for television downlink during next state-side pass ($74^h:57^m$ to $75^h:17^m$ GET). MILA and GDS confirmed that the Voice Operated Gain Adjusted Amplifier) (VOGAA) is out of the circuit for the next pass to insure continuity of downlink voice. The VOGAA was suspected as the trouble for loss of down S/C voice during the first TV transmissions.
74:48	There was no response from either the LM or CSM over HAW and RED to calls from MCC after the first weak hollow response from the LM at 74:47. Simo uplink was confirmed by HAW and RED Communication Techs. Improper VOGAA operation was suspected.
74:57	TV transmission was coming in via GDS before first voice was heard.
75:01	The crew questioned why they did not hear the ground and stated they first heard Houston over the RED. The voice quality from the LM (SPIDER) was noted as being more hollow and tinny sounding during the TV transmissions, than it was before. TV picture quality varied from fair to good as seen on local CBS and NBC off-the-air-monitors.

TIME (GET)	COMMENTS
76:14	Special voice communication test through HAW. VHF only uplink and downlink. The spacecraft was heard loud and clear on Net 1.
76:33	Net 1 became quite noisy but spacecraft voice signal was loud and clear. GDS verified noise was not on downlink. Houston reported to the crew that he "did not know what our communication problems are, but we sure got them".
76:59	The spacecraft did not respond to the first call by MCC through ACN. Uplink was confirmed.
77:01	Spacecraft responded to second call but was weak and noisy, then level improved somewhat. VHF voice was remoted.
77:07	ACN Tech could not at first answer query (on Net 2) as to whether the VOGAA was in or out of the USB receiver downlink because he didn't know what it was. He subsequently verified that the VOGAA was in the circuit.
77:18	No attempt to communicate by voice through TAN. Circuits to the site have been marginal all day.
86:27	Voice signal quality from spacecraft through ACN very good
86:30	ACN was asked to break off transmission of tracking data and restart data flow and retransmit all tracking data.
86:31	CDR was not heard the first time he responded to call through ACN. There apparently was some kind of a communication problem aboard the spacecraft.

TIME (GET)	COMMENTS
87:08	Dump data being received from spacecraft through Guam was noisy. Both EKG's were noisy, respiration clear.
88:04	Net 1 downlink from ACN very noisy throughout pass. No voice communications were observed. Decom patching problem at ACN also suspected.
88:55	VHF relay conversation between CSM and LM indicated failure of both LMP Push-To-Talk buttons in the LM (cable and handle). LMP went to VOX position to transmit although this voice communication configuration did not automatically operate the tape recorder.
90:27	MER was asked by Network to report if they saw any 237.8 mHz downlink.
91:02	ANTIGUA reports they have 237.8 mHz data.
91:19	"Spider" sounded loud and clear from LM through MADRID.
91:21	MADRID can see LM FM subcarrier but no modulation.
91:58	S-Band voice communications from LM and CSM sounds poorly (hollow echo) through HSK.
92:02	HSK reports solid dump.
92:10	Good quality spacecraft voice relayed through the MERCURY.
92:12	MERCURY outputting VHF spacecraft voice because of noise on USB.
92:33	All stations (ANG, VAN, CYI) were advised to provide VHF downlink voice only to GOSS Conference.

TIME (GET)	COMMENTS
92:35	ANG reports no 259.7 mHz downlink.
92:39	CMP reports he cycled latch to free LM from CSM.
93:21	CRO failed to uplink voice communication to spacecraft.
93:26	CRO reported failure of 2 of their 3 decomms on this pass.
93:41	Voice relay between "Gumdrop" (CSM) and "Spider" (LM) was a bit distorted.
93:58	Sites were instructed to uplink VHF and S-Band simultaneously.
95:02	Audio background noise from LM much louder than background noise in CM.
95:15	Unsuccessful attempt to switch spacecraft antenna by ground command through HSK
95:52	"Spider" in the LM had a very weak voice signal level through VANGUARD - downlink voice broke up completely on several occasions and message had to be repeated. When signal came through it was of good quality.
96:04	ARIA 5 acquired spacecraft signal 15 seconds before loss of signal at CYI. ARIA had contact for 11 minutes and heard spacecraft locally but could not satisfactorily remote spacecraft voice to Houston during this pass on either VHF or USB.
96:17	Neither spacecraft (LM or CSM) could be raised through TAN by remote or local means although TAN M&O could be read clearly and he confirmed site was locked on spacecraft.
97:43	Very clear comm via ARIA 5, after initial period of total unintelligibility.
97:49	TAN pass voice was 5 x 0

TIME (GET)	COMMENTS
98:19	HTV pass voice was judged 3 x 1.
99:00	Shortly after docking, loud squeals observed that first sounded like squeals of joy from crew. They re-occurred and it is suspected they were caused by VHF interference instead. They were brief, maybe 5 - 10 sec. This was over VAN.
99:06	Voice Communications from spacecraft via ARIA was in and out, but 2 x 5 when in.
99:25	Over TAN could hear Spider and Gumdrop talking to each other, but Houston was unable to contact them. Later Spider acknowled Houston, said they were pretty busy. Wasn't clear whether they had heard Houston's earlier query or not.
100:25	Crosstalk observed on Net 1, sounded as if it originated from Houston.
100:44	ACN had problems with USB voice from both CSM & LM, confused response on seeing and then not seeing voice subcarriers. It appears ACN heard more than was heard at Houston. Only the VHF voice got to Houston. Some confusion about biomed, apparently due to erroneous or misunderstood configuration message.
101:53	Clear down voice from spacecraft (LM) through GDS was observed during the LM APS ignition.
101:56	TEXAS had valid 2-way lock on the LM for only the initial part of the pass and had trouble reacquiring. They indicated they suspected that another station (MILA?) was uplinking at the same time.
102:00	MILA achieved 2-way ranging on the LM right after APS shut down.

TIME (GET)	COMMENTS
102:05	Houston could not raise Apollo 9 through ANTIGUA although they verified simo VHF/USB uplinking. Apollo 9 did respond on VHF.
103:11	GUAM reported identical voice and signal strengths from the two spacecraft on 296.8 mHz and 259.7 mHz (VHF A and B) during the last pass.
103:27	Crew reported to Houston through the REDSTONE they guess Houston had missed a couple of calls.
104:05	CRO reported uplink mode 1 ranging on LM.
117:36	Command problem - HOU unable to get commands to spacecraft. Some stations around the network report they can see the 30 kHz & 70 kHz turnaround subcarriers and others say they do not. Those seeing the subcarrier report no shift in the modulation when uplinking a command. Houston transmitted an Abort Request command via HSK - spacecraft reported negative on the command. PAO subsequently reported the command problem has been corrected. HOU now uplinking commands. No reason for outage heard
118:41	HOU says they are not getting biomed from crew -- want them to check on grounding.
120:47	Difference in crew voice levels -- suspect microphone positioning
121:00	Because of troubles with a biomed cable, the crew took turns using the same harness. The crew commented that they hoped the doctors could tell the difference since they apparently did not inform the ground that they had changed cables and whose biomed information was being transmitted.

TIME (GET)	COMMENTS
122:00	The downlink through HTV was weak and breaking up. Spacecraft voice was distorted when it came through.
	ANG was not ready for handover at the scheduled time on two consecutive passes apparently because of weak signals. After handover, the downlink voice was fine.
123:00	The downlink was breaking up through TAN and Houston could not read it. The spacecraft later reported that it had read Houston OK.
124:04	The downlink was breaking up through Texas. Houston seemed to think that it was caused by one of the crew since the trouble did not occur when a particular astronaut was talking (Dave Scott - CMP). MIL later said that they observed the same situation, although they could not identify which astronaut was talking. Houston requested the stations to check their downlink for the time that the spacecraft was over TEXAS. MIL reported the downlink was breaking up. The outcome of Houston's investigation is not known.
140:14	On readback of data - lots of noise close to drop out. Believe ANG reporting
140:17	CYI, MSC - Spacecraft requested update but transmission was lost in static during CYI LOS.
142:53	Net 1 sounded like someone blowing in microphone at random intervals
143:05	TEX burst of noise
143:34	(App. TAN) some cross talk and hum observed when HOU talked to spacecraft
143:35	Spacecraft fading in & out; unintelligible.

TIME (GET)	COMMENTS
143:38	Houston reported to spacecraft "situation normal at TAN - am not reading. See you at CRO" then TAN came in with readback from Apollo 9 which was very good comm for that station -- mostly loud and clear with occasional distortion.
144:25	RED had one VHF contact with Apollo 9
145:10	TAN circuit very poor because of HF noise. HOU did not attempt to contact spacecraft this pass.
147:35	RED to Goldstone handover was late due to GDS keyhole. No noise was observed on Net 1.
147:50	USB downvoice signal from the spacecraft through the ANG station varied noticeably in quality and level several times during this station pass.
148:49	Crew was advised over GUAM that their DSE (voice) was good quality only when they talked into the microphone. Crew promised to stay closer (to the microphone)
149:04	Downlink voice on USB was very clear but of low level through the RED
150:39	Noticeable change in downlink voice level through HAW. At times you can hear USB loss of signal on Net 1 before it is announced by M & O or Comm. Tech on Net 2.
164:26	Apollo 9 reported Houston sounded weak, microphone repositioning at MCC corrected problem.
165:45	No attempt to contact thru TAN
165:59	Spacecraft contact through HSK was loud and clear but background noise seemed higher than previous days.

TIME (GET)	COMMENTS
167:09	Spacecraft responded on second call thru TAN. Down voice signal was weak and hollow sounding with high background noise but could be read (∿3 x 3).
167:41	MCC could not raise spacecraft through HTV. HTV CAPCOMM verified signal was uplinking properly.
168:21	VAN Loud and clear
168:45	TAN Loud and clear
168:57	CRO Loud but noisy
169:39	TEX Apollo voice weak and clear -- low noise
169:41	MILA Noisy
169:44	MILA Loud but distorted
169:50	ANG Very loud and clear Apollo 9 voice
169:52	ANG Loud and clear but distorting on high volume syllables
170:48	GWM Loud and clear--very easily intelligible data
171:22	MILA Noisy and undistorted
172:33	ARIA Noisy, varying noise, distortion on high consonants, echoes very bad, in general impossible to read--however Houston could read, "not bad at all".
173:45	Flight Controller press conference declared "ARIA Comm checks over the Pacific were great."
174:07	Spacecraft voice downlink (VHF) through ARIA 2 were of low level and hollow sounding (no high voice frequencies) but very readable. Spacecraft reported uplink on VHF through ARIA was "beautiful."

TIME (GET)	COMMENTS
	When ARIA 2 remoted S-Band voice (and uplinked USB) spacecraft and Houston agreed voice signals were a little weaker. Spacecraft reported noise, and a sweeping tone was observed on Net 1.
174:11	Spacecraft reports Houston coming through very GARBLED. ARIA is now one minute from loss of signal.
189:02	On Net 2 - Communication Tech. asked TEX if they were uplinking voice. TEX replied, "roger" then said "wait one". TEX then came back and said they were getting the Quindar Key tones but were not uplinking. At this time the S/C was heard on Net 2 calling HOU. TEX said everything was OK now. Spacecraft said he read Net 2 5 x 5. At this time VHF contact was established by HOU via MILA.
190:39	On Net 2 - TEX wants to know if HOU was planning to contact S/C via TEX on next pass as they (TEX) were curious as to whether the above problem (189:02) still existed. HOU said negative.
191:19	Only noise bursts heard in attempting spacecraft contact via TAN.
191:50	Same situation when HOU attempted contact via HTV.
192:07	Voice via RED hollow and mushy, but generally readable.
191:10	High-gain Antenna test of CSM performed over CRO and HAW.
193:17	CRO got a reject on a Real Time Command (RTC). CRO had low signal strength at the time.
194:06	Communication through ARIA 5 loud and clear, with some echo.

TIME (GET)	COMMENTS
195:05	GWM got both ground and S/C rejects of an RTC. (Apparently just before LOS.)
195:50	Same comment as above for TAN pass
196:50	S/C reject of RTC from HAW shortly before LOS.
210:18	The downlink through the VAN was so noisy that communications were postponed until the next station. A comment on Net 2 was made that the Vanguard was having trouble with its COMSAT link. (Nature of problem unknown)
211:11	Houston called the spacecraft twice through HSK but received no answer. HSK verified that they had uplink on both occasions. This was only a 4.5 minute contact so there was no further attempt at communication.
211:55	Through BDA, Houston's uplink voice was observed to contain multiple echoes. There were no comments on this from anyone else. The echoes would stop abruptly at times for several minutes.
213:52	Circuit crosstalk observed fading in and out - unintelligible (approaching TAN)
215:23	Some noise and cross talk (through TAN)
216:00	HTV circuit noisy; HOU not able to contact spacecraft
216:12	PAO Acknowledges coversation between S/C and HTV but could not read at MSC
218:12	ANG No-Go for handover due to masking
220:20	Apollo 9 from HOU through TAN. Attempted flight plan update -- spacecraft sounded distorted but was intelligible on read-back

TIME (GET)	COMMENTS
235:50	High background noise on downlink through the Redstone but voice was readable.
235:58	There was continuous contact during this period GYM to CYI and it was one of the few instances where there was considerable voice exchange with the spacecraft. (Maneuver PADS and entry PADS). It was noted that the downlink voice handover was so smooth and clear that no change in signal quality or level was detected during the transfer from one site to the next.
236:32	No attempt was apparently made to contact crew thru TAN.
236:49	EKG data from CMP noted as being missing over CRO. Loose connector found and fixed in spacecraft.
237:10	Spacecraft signal was weak but clear during MER pass.
238:09	Very strong and disturbing echo was observed on both the uplink and downlink transmissions thru TAN. The spacecraft could not be understood by MCC the first time and had to repeat the transmission.
238:58	Redstone could not establish good 2 way lock because of reported low signal strength and state vector update transmission had to be deferred until U.S. pass. (GDS)
239:05	The spacecraft voice was very weak thru the TEX site and message had to be repeated.
239:30	The spacecraft voice was distorted and considerable background noise was observed on the circuit when the signal was passed thru the Ascension Island station.

TIME (GET)	COMMENTS
240:52	The spacecraft voice relay thru the ARIA after blackout was barely readable and MCC asked for a repeat.
240:55	The spacecraft was heard thru the ARIA as weak and hollow sounding but readable.
241:00	Spacecraft CDR reports thru the ARIA relay "crew in good shape" and "on the 'chutes'." There was considerable circuit noise and echo but voice was readable.
241:53	SPLASHDOWN.